

This Page Is Inserted by IFW Operations  
and is not a part of the Official Record

## **BEST AVAILABLE IMAGES**

Defective images within this document are accurate representations of the original documents submitted by the applicant.

Defects in the images may include (but are not limited to):

- BLACK BORDERS
- TEXT CUT OFF AT TOP, BOTTOM OR SIDES
- FADED TEXT
- ILLEGIBLE TEXT
- SKEWED/SLANTED IMAGES
- COLORED PHOTOS
- BLACK OR VERY BLACK AND WHITE DARK PHOTOS
- GRAY SCALE DOCUMENTS

**IMAGES ARE BEST AVAILABLE COPY.**

**As rescanning documents *will not* correct images,  
please do not report the images to the  
Image Problem Mailbox.**



B45

## INTERNATIONAL APPLICATION PUBLISHED UNDER THE PATENT COOPERATION TREATY (PCT)

(51) International Patent Classification 5 :	A1	(11) International Publication Number: WO 93/05425
G02B 26/00 // G09G 3/34		(43) International Publication Date: 18 March 1993 (18.03.93)

(21) International Application Number: PCT/US91/06029

(22) International Filing Date: 29 August 1991 (29.08.91)

(71) Applicant: COPYTELE, INC. [US/US]; 900 Walt Whitman Road, Huntington Station, NY 11746 (US).

(72) Inventors: DISANTO, Frank, J. ; 27 Par Court, North Hills, NY 11030 (US). KRUSOS, Denis, A. ; 1 Lloyd Harbor Road, Lloyd Harbor, NY 11743 (US).

(74) Agent: PLEVY, Arthur, L.; 146 Route #1 North, Edison, NJ 08817 (US).

(81) Designated States: CA, JP, European patent (AT, BE, CH, DE, DK, ES, FR, GB, GR, IT, LU, NL, SE).

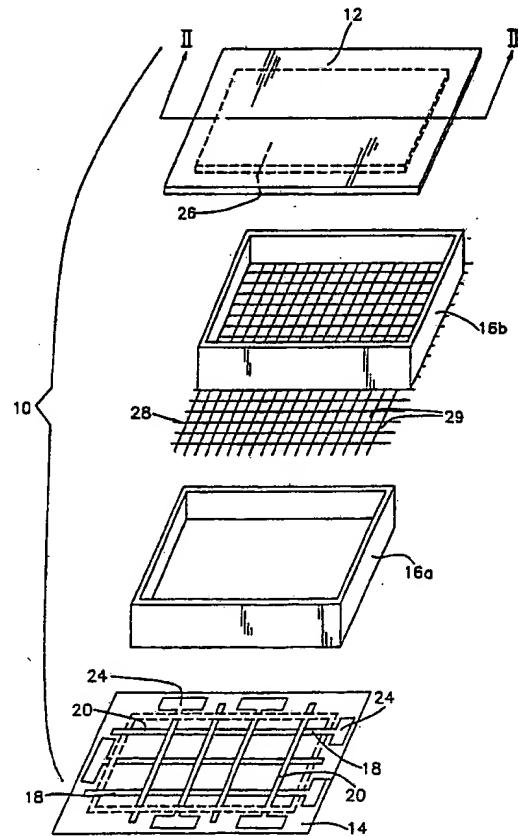
## Published

With international search report.

## (54) Title: ELECTROPHORETIC DISPLAY PANEL WITH INTERNAL MESH BACKGROUND SCREEN

## (57) Abstract

A triode type electrophoretic display (10) includes a pair of substantially identical glass faceplates (12, 14) sealed to a pair of interstitial spacers (16a, 16b) to form a fluid-tight envelope for containing an electrophoretic fluid. An anodized black screen or mesh element (28) is sandwiched between the spacers and is opaque when viewed by the naked eye, thereby providing enhanced background coloration and contrast with pigment particles suspended in the fluid. The mesh (28) occupies an intermediate position relative to the extreme limits of travel of the particles as controlled by grid (18) and cathode (20) deposited upon one faceplate (14) on one side and the anode (26) deposited upon the other faceplate (12) on the other side. The screen (28) is porous, permits particles to pass through it, and is biased electrically to assist in moving the particles during formation of a displayed image.



-1-

Description

Electrophoretic Display Panel  
With Internal Mesh Background Screen

5      Technical Field

The present invention relates to an electrophoretic display panel apparatus and, more particularly, to triode and tetrode-type electrophoretic display panels having an internal mesh screen which enhances display operation.

10      Background Art

Electrophoretic displays (EPIDS) are now well known. A variety of display types and features are taught in several patents issued in the names of the inventors herein, Frank J. DiSanto and Denis A. Krusos and assigned to the assignee herein, Copytele, Inc. of Huntington Station, New York. For example, U.S Patent Nos. 4,655,897 and 4,732,830, each entitled ELECTROPHORETIC DISPLAY PANELS AND ASSOCIATED METHODS describe the basic operation and construction of an electrophoretic display. U.S. Patent No. 4,742,345, entitled ELECTROPHORETIC DISPLAY PANELS AND METHODS THEREFOR, describes a display having improved alignment and contrast. Many other patents regarding such displays are also assigned to Copytele, Inc. Two pending patent applications which may have some relevance to the present invention are Application No. 07/667,630 entitled ELECTROPHORETIC DISPLAY PANEL WITH PLURAL ELECTRICALLY INDEPENDENT ANODE ELEMENTS and Application No. 07/345,825 entitled DUAL ANODE FLAT PANEL ELECTROPHORETIC DISPLAY APPARATUS, each of which shall be described below.

35      The display panels shown in the above-mentioned patents operate upon the same basic principle, viz., if a suspension of electrically charged pigment

-2-

particles in a dielectric fluid is subjected to an applied electrostatic field, the pigment particles will migrate through the fluid in response to the electrostatic field. Given a substantially 5 homogeneous suspension of particles having a pigment color different from that of the dielectric fluid, if the applied electrostatic field is localized it will cause a visually observable localized pigment particle migration. The localized pigment particle migration 10 results either in a localized area of concentration or rarefaction of particles depending upon the sign and direction of the electrostatic field and the charge on the pigment particles. The electrophoretic display apparatus taught in the foregoing U.S. Patents are 15 "triode-type" displays having a plurality of independent, parallel, cathode row conductors or lines deposited on one surface of a glass viewing screen. A layer of insulating photoresist material deposited over the cathode lines and photoetched down to the cathode lines to yield a plurality of insulator strips positioned transverse to the cathode lines, forms the substrate for a plurality of independent, parallel column or grid conductor lines. The resultant cathode 20 and grid lines form an X-Y matrix for addressing the display and the columns and rows are arranged 25 respectively in the horizontal and vertical directions or vice versa.

A glass cap member forms a fluid-tight seal with the viewing window along the cap's peripheral edge for containing the fluid suspension and also acts as a substrate for an anode plate deposited on the interior 30 flat surface of the cap. When the cap is in place, the anode surface is in spaced parallel relation to both the cathode and the grid matrix. Given a

-3-

specific particulate suspension, the sign of the electrostatic charge which will attract and repel the pigment particles will be known. The cathode voltage, the anode voltage, and the grid voltage can then be  
5 ascertained such that when a particular voltage is applied to the cathode and another voltage is applied to the grid, the area proximate their intersection will assume a net charge sufficient to attract or repel pigment particles in suspension in the  
10 dielectric fluid. Since numerous cathode and grid lines are employed, there are numerous discrete intersection points which can be controlled by varying the voltage on the cathode and grid lines to cause localized visible regions of pigment concentration and  
15 rarefaction. Essentially then, the operating voltages on both cathode and grid must be able to assume at least two states corresponding to a logical one and a logical zero. Logical one for the cathode may either correspond to attraction or repulsion of pigment.  
20 Typically, the cathode and grid voltages are selected such that only when both are a logical one at a particular intersection point, will a sufficient electrostatic field be present at the intersection relative to the anode to cause the writing of a visual  
25 bit of information on the display through migration of pigment particles. The bit may be erased, e.g., upon a reversal of polarity and a logical zero-zero state occurring at the intersection coordinated with an erase voltage gradient between anode and cathode. In  
30 this manner, digitized data can be displayed on the electrophoretic display.

-4-

An alternative EPID construction is disclosed in Application Serial No. 07/667,630, referred to above, which relates to an electrophoretic display in which the previously described grid of electrically 5 independently controllable elements or lines is replaced with a monolithic or electrically continuous grid. Further, the monolithic anode is replaced with a plurality of discrete, electrically independent elements. In displays constructed in accordance with 10 the teachings of the aforesaid application, pixel writing and erasure is accomplished by impressing a voltage gradient between a selected anode element and a selected intersecting cathode line such that at their point of intersection, the gradient is 15 sufficient to overcome a constant barrier voltage on the monolithic grid element causing migration of pigment particles past the grid.

A further alternative EPID construction is described in Application No. 07/345,825, referred to 20 above, which relates to an electrophoretic display in which the cathode/grid matrix as is found in triode-type displays is overlayed by a plurality of independent separately addressable "local" anode lines. The local anode lines are deposited upon and 25 align with the grid lines and are insulated therefrom by interstitial lines of photoresist. The local anode lines are in addition to a "remote" anode, which is a layer deposited upon the anode faceplate as in triode displays. The dual anode structure aforesaid provides 30 enhanced operation by eliminating unwanted variations in display brightness between frames, increasing the speed of the display and decreasing the anode voltage

-5-

required during Write and Hold cycles, all as explained in Application No. 07/345,825, which is incorporated herein by reference.

5 To be useful as a display, an electrophoretic display must be able to assume a blank or erased state; must be able to display character data written during a Write operation; and must be able to continually maintain or hold the written characters (and blank characters) in a Hold mode until they are 10 erased or overwritten. These three modes of operation, i.e., Erase, Write and Hold are well documented in existing patents issued to the inventors herein and such description shall not be repeated at length herein.

15 One aspect of visual displays of all kinds which is a constant object of improvement is the clarity or resolution of the display. Resolution is at least partially dependent upon the size and number of the pixels which comprise the image. Resolution is also a 20 function of the number of lines per inch associated with the display as well as the number of pixels per line. As is known in monochromatic displays, data can be displayed using two colors, i.e., a foreground color (A) and a background color (B) which may be 25 interchangeable or reversible. That is, in a first mode of operation, color (A) is selected as foreground and color (B) serves as the background color. In a second mode of operation, color (B) is used to represent foreground data and color (A) to represent 30 the background. A frequently used color combination in an electrophoretic display is a yellow foreground against black/dark blue background, i.e., yellow pigment particles are suspended in a black/dark blue solution. In many instances, the solution is colored

-6-

by a black/dark blue dye dissolved in a solvent. In order to achieve a sharp color contrast between the light colored pigment particles and the dark solution, a high concentration of dye is normally required. A 5 high concentration is required due to the transparency of EPID displays (absent the dye) and to the thickness of the display. Since the dark solution fills the EPID display and surrounds the light colored pigment particles, high dye concentrations diminish display 10 brightness and contrast. That is, even when the pigment particles are in the display position, not all dye is excluded from in between the particles or from in between the particle agglomeration and the glass faceplate through which it is viewed.

15 It is therefore an object of the present invention to provide an electrophoretic display with increased brightness and contrast by substantially reducing the above-described unwanted dye effect.

Disclosure of the Invention

20 The problems and disadvantages associated with the image resolution and brightness of conventional electrophoretic displays using contrast dye in the electrophoretic fluid are overcome by the present invention which includes an electrophoretic display 25 having a fluid-tight envelope with a portion thereof which is at least partially transparent. An electrophoretic fluid is contained within the envelope and has pigment particles suspended therein. The display has electronics for selectively positioning 30 the particles within the envelope such that they form images which are visible to a viewer when viewed through the transparent portion. A screen or mesh is disposed within the envelope and divides an interior space in the envelope containing the fluid into a

-7-

front portion proximate the transparent portion of the envelope and a back portion distal to the transparent portion. The mesh is at least partially opaque when viewed through the transparent portion of the envelope and obscures the particles from being viewed through the transparent portion when the particles are in the back portion. The screen or mesh allows the particles to pass through the pores under the control of the electronics such that the particles can be viewed or obscured depending upon their position with respect to the screen.

Brief Description of the Drawings

FIG. 1 is an exploded perspective view of an electrophoretic display in accordance with an exemplary embodiment of the present invention.

FIG. 2 is a cross-sectional view of the electrophoretic display shown in FIG. 1 in the unexploded state, taken along section line II-II and looking in the direction of the arrows.

FIG. 3 is an exploded perspective view of an electrophoretic display in accordance with a second exemplary embodiment of the present invention.

FIG. 4 is a cross-sectional view of the electrophoretic display shown in FIG. 3 in the unexploded state, taken along section line IV-IV and looking in the direction of the arrows.

FIG. 5 is a schematic diagram showing the connection of the devices depicted in FIGS. 1 through 4 to a power supply as controlled by a controller.

Best Mode for Carrying Out The Invention

FIG. 1 shows an electrophoretic display 10 in accordance with the present invention. The display 10 has an anode faceplate 12 and a cathode faceplate 14 which are sealably affixed on either side of

interstitial spacers 16a and 16b to form a fluid tight envelope for containing dielectric/pigment particle suspension or electrophoretic fluid (not shown). The faceplates 12 and 14 are typically flat glass plates upon which are deposited conductor elements. The techniques, materials and dimensions used to form the conductor elements upon the faceplates and the methods for making EPIDS, in general, are shown in U.S. Patent Nos. 4,655,897, 4,732,830 and 4,742,345 which patents are incorporated herein by reference.

As depicted in FIG. 1, a plurality of independent, electrically conductive cathode elements or lines 18 (horizontal rows) are deposited upon the cathode faceplate 14 using conventional deposition and etching techniques. It is preferred that the cathode members 18 be composed of Indium Tin Oxide (ITO) as set forth in U.S. Patent No. 4,742,345. A plurality of independent grid conductor elements or lines 20 are superposed in the vertical over the cathode lines 18 and are insulated therefrom by an interstitial photoresist layer 22 (see FIG. 2). The terms horizontal and vertical are used in regard to the orientation shown in Figure 1, but can be interchanged. The grid lines 20 may be formed by coating the photoresist layer 22 with a metal, such as nickel, using sputtering techniques or the like, and then selectively masking and etching to yield the intersecting but insulated configuration shown in FIGS. 1 and 2. Each cathode and grid line 18, 20 terminates at one end in a contact pad 24 or is otherwise adapted to permit connection to display driver circuitry (not shown). An anode 26 is formed on an interior surface of the anode faceplate 12 by plating with a thin layer of conductor material, such

as, chrome. A novel mesh element or screen 28 is sandwiched between spacers 16a and 16b to provide at least a partial barrier to the passage of light through the EPID 10. The mesh 28 has a plurality of pores 29 through which pigment particles may pass so as not to obstruct the normal operation of the EPID. Coincidental to the light barrier function, the mesh itself is an optically significant element, i.e., it is readily visible to the naked eye. In a preferred form, the mesh is constructed in a manner so that it is maximally visible, but the pores in the mesh are not visible, i.e., it is preferred that the mesh appear as a flat planar object. This is achieved by making the mesh with the minimum pore size which does not critically impede pigment movement. A screen having suitable characteristics is commercially available from the Buckee Mears Co., viz., a perforated stainless steel mesh having an approximate thickness and pore size of 10 to 12 mils. The mesh has an open area ratio, i.e., the ratio of the sum of pore area to the total surface area on one surface of the screen, of approximately 40% to 50%. The mesh is blackened by an anodizing process. The significance of the mesh screen 28 is that it provides a solid visual background for the display of pixels and it permits a reduction of dye concentration to effect a desired background intensity. For example, if the mesh were used in an EPID utilizing black/dark blue solution and yellow pigment particles, it could be colored black on at least one side so that the blackened side would function as a black background to enhance the background intensity attributable to the solution. It has been observed that the above-described mesh screen provides such an effective

-10-

background that no dye is required. Even if a less effective mesh were used, the objective of increased contrast would be realized because dye concentration along with unwanted dye effects could be decreased.

5      The screen 28 also functions to prevent inadvertent backlighting due to the overall translucence of the EPID 10. Since the screen allows for the reduction or elimination of dye, the pigment particles are more readily visible when in the display position and display brightness and contrast are increased. It

10     should be observed that the screen 28 is positioned in the EPID 10 such that when the pigment is in the display position, it is on one side of the screen 28 and when it is in the fully written position it is on

15     the other side of the screen 28, obscured from view by the screen 28 and/or dye in the solution.

It is preferable to fabricate the screen 28 from a conductive material enabling the screen to carry an electric charge for the purpose of aiding in controlling the movement of the pigment particles. By utilizing the screen 28 as an electrode, the effect of the screen 28 as a physical barrier is compensated for and permits it to act solely as a visual barrier.

To form an EPID 10 like that shown in FIG. 1, the parts may assembled in a stack and placed in an oven for baking. The spacers 16a and 16b, in that case, would be coated on surfaces which contact adjacent elements with a material which would become plastic at baking temperatures, such as, epoxy. Upon baking, the meltable material flows and the elements form a laminate upon cooling. Of course, other methods exist within the scope of the normally skilled artisan for assembling the elements of the EPID 10 shown, such as,

e.g., gluing. The lamination of the EPID elements forms an envelope for containing the dielectric fluid/pigment particle suspension.

5 The cathode and grid lines 18 and 20 of the electrophoretic display 10 can assume a variety of voltages during operation for controlling the display operations of erase, hold and write. A typical panel has a large number of intersections, e.g., 2,200 X 1,700 or a total of 3,740,000 separately addressable 10 intersection points. For ease of illustration, however, only a few cathode lines 18 and grid lines 20 are depicted. Similarly, the shape and proportions of the elements depicted are for purposes of illustration only. The dimensions of the respective elements have 15 also been greatly enlarged for illustration and are not necessarily in proportion to an actual operational device. More illustrations of electrophoretic displays, their components and electrical circuitry can be seen by referring to U.S. Patents Nos. 20 4,742,345 and 4,772,820, each being awarded to the inventors herein and which are incorporated by reference herein.

25 Certain details have been omitted from the device depicted, but are taught in prior patents. For example it has been determined that a  $\text{SiO}_2$  coating on certain of the conductor elements provides beneficial results. See Application No. 07/675,733. Similarly, conductor elements having a tined configuration provide enhanced resolution, see U.S. Patent No. 30 4,742,345.

FIG. 2 shows the electrophoretic display of FIG. 1 assembled and in cross-section. The anode 26 in the embodiment shown, is a plate-like area of conductor material having a length and width essentially

-12-

matching that of the cathode/grid matrix, i.e., coextensive with the matrix, as is taught in the above referenced patents and applications of the present Applicant. The cathode elements 18, grid elements 20 and grid insulator strips 22 as are also like those shown in the foregoing patents, etc. Since all conductor elements are quite thin, they extend beneath the interstitial spacers 16a and 16b without special provision and at least one end thereof provide a terminal exterior to the envelope for connecting display driver circuitry (not shown). For the purposes of illustration, epoxy bonding material 30 is depicted providing the laminating bond between spacers 16 and the faceplates 12 and 14 and for laminating the mesh screen 28 between the spacers 16a and b.

As stated above, the mesh screen 28 is preferably formed from a conductive material and is electrically biased to overcome any physical barrier it presents to particle migration. Exemplary voltages applied to the various elements in the EPID to perform certain basic functions are set forth below.

For the following operations, typical voltages would be:

+V1 = +200 (PULSED TO +400 DURING WRITING OF IMAGE)

-V1 = -300

+V2 = +140

-V2 = -200

30  $V_G$  HIGH = 0 (PULSED TO +3.0 DURING WRITING OF IMAGE)

$V_G$  LOW = -10

VAC = 100 V RMS

$V_K$  HIGH = +15 (PULSED TO +18 DURING WRITING OF IMAGE)

$V_K$  LOW = 0

-13-

FULL WRITE:

V ANODE = +V1  
V MESH = VAC  
5 V GRID =  $V_G$  HIGH  
V CATH =  $V_K$  LOW

ERASE:

V ANODE = -V1  
10 V MESH = -V2  
V GRID =  $V_G$  HIGH  
V CATH =  $V_K$  LOW

HOLD:

15 V ANODE = +V1  
V MESH = +V2  
V GRID =  $V_G$  LOW  
V CATH =  $V_K$  HIGH

20 PREPARE FOR SELECTIVE IMAGE WRITING:

Set V MESH = VAC for 2 seconds, then return  
V MESH = +V2

TO WRITE AN IMAGE:

25 V ANODE = +V1  
V MESH = pulsed from +V2 to +V1 (+400)  
The image is then written in the usual manner by  
loading data into the grid elements and sequentially  
making each cathode low.

30

-14-

TO HOLD WRITTEN IMAGE

5 V ANODE = +V1

V MESH = VAC

V GRID =  $V_G$  LOW

V CATH =  $V_K$  HIGH

After 2 seconds return V MESH = +V2

TO REMOVE POWER FROM THE DISPLAY WITHOUT DISTURBING  
THE IMAGE:

10 V ANODE = +V1

V MESH = -V1

V GRID =  $V_G$  HIGH

V CATH =  $V_K$  LOW

15 Power is then removed from the anode, grid,  
cathode and mesh in that order. The display is thus  
completely removed from power, but the image displayed  
remains undisturbed.

20 By writing with AC on the mesh and a positive  
voltage on the anode, all pigment has been removed  
from the front surface and only the black mesh is  
visible. Thus, even in a suspension which is  
completely devoid of dye, the black background is very  
black and the pigment appears much brighter, improving  
contrast and permitting the panel to be operated at a  
25 lower illumination.

30 FIGS 3 and 4 illustrate the incorporation of the  
above-described mesh screen 28 into a tetrode-type  
display. As can be readily determined by comparing  
FIGS 1 and 2 to FIGS 3 and 4, many of the basic  
elements of the display 10 are similar or the same in  
both triode and tetrode-type displays. The same  
reference numerals identifying similar elements shared  
by both embodiments are employed to point out this

-15-

similarity. The embodiment shown in FIGS 3 and 4 differs from that previously described with respect to the addition of a plurality of local anode elements 32 which are deposited upon corresponding photoresist insulator strips 34 (see FIG. 4) formed upon the grid elements 20. The methods for forming the local anode elements 32 are set forth at length in Application No. 07/345,825. In brief, a layer of photoresist is applied over the grid elements 20, which are formed from a first metal, such as, chrome. A layer of a second metal, e.g., nickel or aluminum, is applied over the photoresist layer. Yet another layer of photoresist is applied over the second metal layer, and is then masked, exposed and developed in the same form as the grid elements. The second metal layer is then etched with a suitable solution. The photoresist between the first and second metal layers is then plasma etched. A layer of  $\text{SiO}_2$  is then deposited over the resulting structure.

As in the triode-type display, the screen 28 is preferably constructed from a conductor material and is electrically biased to assist in pigment particle position control. The following are exemplary voltages applied to the aforesaid elements to effect certain basic display operations.

For the following operations, typical voltages would be:

+V1 = +200 (PULSED TO +400 DURING WRITING OF IMAGE)

-V1 = -300

+V2 = +140

-V2 = -200

$V_G$  HIGH = 0 (PULSED TO +3.0 DURING WRITING OF IMAGE)

-16-

V<sub>G</sub> LOW = -10V<sub>K</sub> HIGH = +15 (PULSED TO +18 DURING WRITING OF IMAGE)V<sub>K</sub> LOW = 0

VLAH = +20 (PULSED TO +32 DURING WRITING OF IMAGE)

5 V3 = +20 (PULSED TO +32 DURING WRITING OF IMAGE)

VAC = 100 V RMS

(ANODE = REMOTE ANODE; L.A. = LOCAL ANODE)

## FULL WRITE:

10 V ANODE = +V1

V MESH = VAC

V L.A. = 0

V GRID = V<sub>G</sub> HIGHV CATH = V<sub>K</sub> LOW

15

## ERASE:

V ANODE = -V1

V MESH = +V3

V L.A. = 0

20 V GRID = V<sub>G</sub> HIGHV CATH = V<sub>K</sub> LOW

## HOLD:

V ANODE = +V1

25 V MESH = +V2

V L.A. = 0

V GRID = V<sub>G</sub> LOWV CATH = V<sub>K</sub> HIGH

30 PREPARE FOR SELECTIVE IMAGE WRITING:

Connect MESH to VAC for 2 seconds

Return MESH to +V2

Connect REMOTE ANODE and MESH to LOCAL ANODE

V ANODE = VLAH

-17-

V MESH = VLAH  
V L.A. = VLAH  
V GRID =  $V_G$  LOW  
V CATH =  $V_K$  HIGH

5

TO WRITE IMAGE:

The image is written in the usual manner by loading data into the grid elements and sequentially making each cathode low.

10

HOLD IMAGE:

After writing the image, set the voltages as follows:

15

V ANODE = VLAH  
V MESH = VLAH  
V L.A. = VLAH  
V GRID =  $V_G$  LOW  
V CATH =  $V_K$  HIGH

20

HOLD IMAGE WITHOUT POWER:

To completely remove power from the panel without losing the image, proceed as follows:

25

V ANODE = +V1  
V MESH = +V2  
V L.A. = 0  
V GRID =  $V_G$  LOW  
V CATH =  $V_K$  HIGH  
V MESH = VAC FOR 2 SECONDS  
V MESH = RETURN TO -V1

30

REMOVE VOLTAGE FROM ANODE, GRID, CATHODE AND MESH

HOLD IMAGE WITHOUT POWER ALTERNATE:

An alternate method for removing power from the panel without losing the image is:

-18-

V ANODE = VLAH

V MESH = -V2

V L.A. = VLAH

5 V GRID = V<sub>G</sub> LOW

V CATH = V<sub>K</sub> HIGH

Remove voltage from ANODE, LOCAL ANODE, GRID, CATHODE, and finally MESH.

10 By connecting the mesh to AC in the HOLD state and pulsing the positive anode, all excess goes through the mesh holes to the anode and after writing to the local anode, in the areas where pigment has been removed from the front surface, only the black mesh screen is visible. Thus, the suspension does not 15 contain dye and the pigment brightness is greatly enhanced. Since the black is very dark and the pigment is brighter, the contrast is better and the panel may be viewed at lower illumination.

20 FIG. 5 illustrates in schematic form how the various components of the electrophoretic displays described above in reference to FIGS. 1 through 4 might be electrically connected to a suitable power supply 36 under the control of a digital controller 38 in order to assume the correct voltage states during 25 the operations described.

30 It should be understood that the embodiments described herein are merely exemplary and that a person skilled in the art may make many variations and modifications without departing from the spirit and scope of the invention as defined in the appended claims.

-19-

Claims

1. An electrophoretic display comprising:

(a) a fluid-tight envelope having a portion thereof which is at least partially transparent;

5 (b) an electrophoretic fluid contained within said envelope, said fluid having pigment particles suspended therein;

10 (c) means for selectively positioning said particles within said envelope such that said particles form images which are visible to a viewer when viewed through said transparent portion; and

15 (d) a mesh disposed within said envelope dividing an interior space in said envelope containing said fluid into a front portion proximate said transparent portion of said envelope and a back portion distal to said transparent portion, said mesh being at least partially opaque when viewed through said transparent portion of said envelope and obscuring said particles from being viewed through said transparent portion when said particles are in said back portion, said mesh allowing said particles to pass through under the control of said positioning means such that said particles can be viewed or obscured depending upon the position of said particles with respect to said mesh.

20 2. The display of Claim 1, wherein said pigment particles have a color which is differentiable from that of said fluid and from that of said screen.

25 3. The display of Claim 2, wherein said mesh is composed of an electrically conductive material and is selectively electrically chargeable to induce movement of said particles within said fluid in cooperation with said positioning means.

-20-

4. The display of Claim 3, wherein the open area ratio for said mesh is approximately from 40% to 50%.

5. The display of Claim 4, wherein said mesh is black in color.

6. The display of Claim 5, wherein said fluid is at least partially transparent.

7. The display of Claim 6, wherein said mesh is anodized.

10 8. The display of Claim 7, wherein said pigment particles are yellow.

15 9. The display of Claim 8, wherein said display has a first operating mode in which said pigment particles represent the foreground component of a displayed monochrome image and said mesh represents the background component of said displayed image and a second operating mode in which said pigment particles represent the background component of said displayed monochrome image and said mesh represents the foreground component of said displayed image.

20 10. The display of Claim 9, wherein said display is a triode-type display having an anode disposed proximate said transparent portion and a cathode and a grid disposed in said back portion and said positioning means includes said cathode, said grid and said anode.

11. The display of Claim 10, wherein said transparent portion of said envelope includes a portion through which said back portion can be viewed.

30 12. The display of Claim 9, wherein said display is a tetrode-type display having a remote anode disposed proximate said transparent portion, a cathode, a grid and a local anode disposed in said

-21-

back portion and said positioning means includes said cathode, said grid, said remote anode and said local anode.

5 13. The display of Claim 12, wherein said transparent portion of said envelope includes a portion through which said back portion can be viewed.

14. An electrophoretic display comprising:

(a) a fluid-tight envelope having a portion thereof which is at least partially transparent;

10 (b) an electrophoretic fluid contained within said envelope, said fluid having pigmented particles suspended therein;

15 (c) a plurality of elongated substantially parallel horizontal conductor members disposed within a first plane and at least partially contained within said envelope;

20 (d) a plurality of elongated substantially parallel vertical conductor members at least partially contained within said envelope electrically insulated from said horizontal members and disposed within a second plane, said first and said second planes being substantially parallel and in proximity to each other, said plurality of horizontal members and said plurality of vertical members forming a matrix with a plurality of intersections when viewed along a line perpendicular to said first and said second planes;

25 (e) a substantially planar conductor member disposed within a third plane proximate and substantially parallel to said second plane and at least partially contained within said envelope; and

30 (f) a perforated screen disposed between said vertical members and said planar member, said screen allowing said pigment particles to pass through the perforations thereof and being at least partially

-22-

5 opaque when viewed through said transparent portion of said envelope, each of said vertical and said horizontal members in said matrix being selectively electrically chargeable to induce movement of said particles within said fluid, said particles being visible through said transparent portion of said envelope.

10 15. The display of Claim 14, wherein said screen is substantially coextensive with said horizontal members and with said vertical members and has a color contrasting with that of said pigment particles.

15 16. The display of Claim 15, wherein said screen is composed of an electrically conductive material and is electrically insulated from said vertical and planar members.

20 17. The display of Claim 16, wherein said screen is selectively electrically chargeable to induce movement of said particles within said fluid in cooperation with said selectively electrically chargeable horizontal and vertical members.

18. The display of Claim 17, wherein said fluid is substantially transparent.

25 19. The display of Claim 18, wherein said envelope includes a first flat faceplate, a central portion of which is said transparent portion of said envelope, said first faceplate being a substrate for supporting said planar member.

30 20. The display of Claim 19, wherein said envelope includes a second substantially flat faceplate and at least one spacer interposed between and sealably attached to said first and second faceplates to form said envelope, said first plurality of horizontal conductor members being positioned proximate said second faceplate.

-23-

21. The display of Claim 20, wherein said at least one spacer includes two spacers, a first sealably affixed to said first faceplate and a second sealably affixed to said second faceplate, said first and second spacers sealably affixing to each other distal to said first and second faceplates and sandwiching said screen therebetween.

5 22. The display of Claim 21, wherein the open area ratio for said screen is approximately from 40% to 50%.

10 23. The display of Claim 22, wherein said second faceplate is a substrate for supporting said first plurality of horizontal conductor members.

15 24. The display of Claim 23, wherein said second faceplate is at least partially transparent and said electrophoretic fluid is visible therethrough, said display being in its entirety at least partially translucent in a direction perpendicular to said first and second faceplates.

20 25. The display of Claim 24, wherein said screen reduces the translucence of said display.

26. The display of Claim 25, wherein said screen is black in color.

25 27. The display of Claim 26, wherein said screen is anodized.

28. The display of Claim 27, wherein said pigment particles are yellow.

30 29. The display of Claim 18, wherein said display has a first operating mode in which said pigment particles represent the foreground component of a displayed monochrome image and said screen represents the background component of said displayed image and a second operating mode in which said pigment particles represent the background component

-24-

of said displayed monochrome image and said screen represents the foreground component of said displayed image.

30. The display of Claim 18, wherein a dye of  
5 approximately the same color as said screen is added to said fluid.

31. The display of claim 23, wherein said display is a triode-type display, said plurality of horizontal members being the cathode, said plurality of vertical members being the grid and said planar member being the anode.  
10

32. The display of Claim 23, wherein said display is a tetrode-type display, said plurality of horizontal members being the cathode, said plurality of vertical members being the grid and said planar member being the remote anode and further including a plurality of local anode elements deposited upon said grid elements in alignment therewith and insulated therefrom by interstitial insulator strips.  
15

33. In an electrophoretic display of the type having a cathode matrix comprising a plurality of parallel lines arranged in a given direction, with a grid matrix insulated from said cathode matrix and comprising a plurality of parallel lines each perpendicular to said cathode lines to form an X-Y addressing matrix with a conventional anode electrode separated from said X-Y matrix with the space between said anode electrode and said X-Y matrix accommodating an electrophoretic dispersion including pigment particles suspended in a fluid, the improvement therewith of:  
20  
25  
30

-25-

5 a mesh disposed within said space between said anode electrode and said X-Y matrix, said mesh allowing said pigment particles to pass therethrough under the control of said anode and said X-Y matrix,  
said mesh being at least partially opaque and providing a contrasting background for said pigment particles.

10 34. The device of Claim 33, wherein said mesh is perforated by a plurality of perforations through which said particles pass, said mesh when interposed between a viewer and said pigment particles at least partially obscuring said pigment particles from view.

15 35. The device of Claim 34, wherein said pigment particles have a color which is differentiable from that of said fluid and from that of said mesh.

20 36. The device of Claim 35, wherein said screen is composed of an electrically conductive material and is selectively electrically chargeable to induce movement of said particles within said fluid in cooperation with said X-Y matrix and said anode.

37. The device of Claim 36, wherein the open area ratio for said mesh is approximately from 40% to 50%.

25 38. The device of Claim 37, wherein said mesh is black in color.

39. The device of Claim 38, wherein said fluid is at least partially transparent.

40. The device of Claim 39, wherein said mesh is anodized.

30 41. The device of Claim 40, wherein said pigment particles are yellow.

-26-

42. The device of Claim 41, wherein said display has a first operating mode in which said pigment particles represent the foreground component of a displayed monochrome image and said screen represents the background component of said displayed image and a second operating mode in which said pigment particles represent the background component of said displayed monochrome image and said mesh represents the foreground component of said displayed image.

10 43. The device of Claim 42, wherein said display further includes an additional anode electrode comprising a plurality of parallel lines each associated with and insulated from a respective grid line with said additional anode operative to control the path of said pigment particles to and from said X-Y matrix and through said mesh and to allow excess pigment to remain at said conventional anode electrode.

20 44. A method for operating an electrophoretic display of the type having a cathode matrix comprising a plurality of parallel lines arranged in a given direction, with a grid matrix insulated from said cathode matrix and comprising a plurality of parallel lines each perpendicular to said cathode lines to form an X-Y addressing matrix with a conventional anode electrode separated from said X-Y matrix with the space between said anode electrode and said X-Y matrix accommodating an electrophoretic dispersion including pigment particles suspended in a fluid, and a screen composed of an electrically conductive material disposed within said space between said anode electrode and said X-Y matrix, said screen allowing said pigment particles to pass therethrough under the control of said anode and said X-Y matrix, said screen

25

30

-27-

being at least partially opaque and providing a contrasting background for said pigment particles includes the steps of;

5 (a) electrically connecting said cathode matrix, said grid matrix, said screen and said conventional anode to a source of electrical potential energy, said source providing a range of independent and selectively variable voltages to each of said cathode matrix, said grid matrix, said screen and said anode under the control of control means for controlling the voltage level supplied by said source to each of said cathode matrix, said grid matrix, said screen and said anode; and

10 15 (b) controlling said source of electrical potential energy with said control means such that voltage levels are applied to said cathode matrix, said grid matrix, said screen and said anode for performing display operations.

20 25 45. The method of Claim 44, wherein said display operations include placing said display in FULL WRITE mode by said source providing under the control of said control means approximate voltage levels of +200 v to said anode, 100 v rms AC to said screen, +1.5 to +3.0 v to said grid matrix and -10 v to said cathode matrix.

30 46. The method of Claim 44, wherein said display operations include placing said display in ERASE mode by said source providing under the control of said control means approximate voltage levels of -300 v to said anode, -200 v to said screen, +1.5 to +3.0 v to said grid matrix and -10 v to said cathode matrix.

-28-

47. The method of Claim 46, wherein said display operations include placing said display in ERASE-HOLD mode, after having placed said display in ERASE mode, by said source providing under the control of said control means approximate voltage levels of +200 v to said anode, +140 v to said screen, -10 v to said grid matrix and +1.5 to +3.0 v to said cathode matrix.

48. The method of Claim 47, wherein said display operations include writing an image on said display after said display is in ERASE-HOLD mode by said source providing under the control of said control means approximate voltage levels of 100 v rms AC to said screen for about 2 seconds then +140 v to said screen, +200 v to said anode, then pulsing the voltage on said screen from +140 to +400 while said image is written, and by loading image data into said grid elements and sequentially placing each cathode element at -10 v.

49. The method of Claim 48, wherein said display operations include placing said display in an IMAGE-HOLD mode wherein a written said image is held on said display by said source providing under the control of said control means approximate voltage levels of 100 v rms AC to said screen for about 2 seconds then +140 v to said screen, +200 v to said anode, -10 v to said grid matrix and +1.5 to 3.0 v to said cathode matrix.

50. The method of Claim 49, wherein said display operations include placing said display in a POWER-OFF-IMAGE-HOLD mode wherein a written said image is held on said display after the removal of power from said display, said POWER-OFF-IMAGE-HOLD mode being achieved by said source providing under the control of

said control means approximate voltage levels of +200 v to said anode, -300 v to said screen, +1.5 to 3.0 v to said grid matrix and -10 v to said cathode matrix.

5 51. The method of Claim 44, wherein said display further includes an additional anode electrode comprising a plurality of parallel lines each associated with and insulated from a respective grid line with said additional anode operative to control the path of said pigment particles to and from said X-Y matrix and through said screen and to allow excess pigment to remain at said conventional anode electrode and further comprising the step of electrically connecting said controlled source of electrical potential energy to said additional anode, voltage levels supplied to said additional anode being included in said step of controlling for performing display operations.

20 52. The method of Claim 51, wherein said display operations include placing said display in FULL WRITE mode by said source providing under the control of said control means approximate voltage levels of +200 v to said conventional anode, 0 v to said additional anode, 100 v rms AC to said screen, +1.5 to +3.0 v to said grid matrix and -10 v to said cathode matrix.

25 53. The method of Claim 51, wherein said display operations include placing said display in ERASE mode by said source providing under the control of said control means approximate voltage levels of -300 v to said conventional anode, 0 v to said additional anode, +20 v to said screen, +1.5 to +3.0 v to said grid matrix and -10 v to said cathode matrix.

-30-

54. The method of Claim 53, wherein said display operations include placing said display in ERASE-HOLD mode after having placed said display in ERASE mode, by said source providing under the control of said control means approximate voltage levels of +200 v to said conventional anode, 0 v to said additional anode, +140 v to said screen, -10 v to said grid matrix and +1.5 to +3.0 v to said cathode matrix.

10 55. The method of Claim 54, wherein said display operations include writing an image on said display after said display is in ERASE-HOLD mode by said source providing under the control of said control means approximate voltage levels of 100 v rms AC to said screen for about 2 seconds then +140 v to said screen, +200 v to said conventional anode after said conventional anode, said additional anode and said screen are electrically connected, and writing said image by loading image data into said grid elements and sequentially placing each cathode element at -10 v.

15 20 25 56. The method of Claim 55, wherein said display operations include placing said display in an IMAGE-HOLD mode wherein a written said image is held on said display by said source providing under the control of said control means approximate voltage levels of +200 v to said conventional anode, +200 v to said screen, +200 to said additional anode, -10 v to said grid matrix and +1.5 to 3.0 v to said cathode matrix.

30 35 40 45 50 55 60 65 70 75 80 85 90 95 100 105 110 115 120 125 130 135 140 145 150 155 160 165 170 175 180 185 190 195 200 205 210 215 220 225 230 235 240 245 250 255 260 265 270 275 280 285 290 295 300 305 310 315 320 325 330 335 340 345 350 355 360 365 370 375 380 385 390 395 400 405 410 415 420 425 430 435 440 445 450 455 460 465 470 475 480 485 490 495 500 505 510 515 520 525 530 535 540 545 550 555 560 565 570 575 580 585 590 595 600 605 610 615 620 625 630 635 640 645 650 655 660 665 670 675 680 685 690 695 700 705 710 715 720 725 730 735 740 745 750 755 760 765 770 775 780 785 790 795 800 805 810 815 820 825 830 835 840 845 850 855 860 865 870 875 880 885 890 895 900 905 910 915 920 925 930 935 940 945 950 955 960 965 970 975 980 985 990 995 1000 1005 1010 1015 1020 1025 1030 1035 1040 1045 1050 1055 1060 1065 1070 1075 1080 1085 1090 1095 1100 1105 1110 1115 1120 1125 1130 1135 1140 1145 1150 1155 1160 1165 1170 1175 1180 1185 1190 1195 1200 1205 1210 1215 1220 1225 1230 1235 1240 1245 1250 1255 1260 1265 1270 1275 1280 1285 1290 1295 1300 1305 1310 1315 1320 1325 1330 1335 1340 1345 1350 1355 1360 1365 1370 1375 1380 1385 1390 1395 1400 1405 1410 1415 1420 1425 1430 1435 1440 1445 1450 1455 1460 1465 1470 1475 1480 1485 1490 1495 1500 1505 1510 1515 1520 1525 1530 1535 1540 1545 1550 1555 1560 1565 1570 1575 1580 1585 1590 1595 1600 1605 1610 1615 1620 1625 1630 1635 1640 1645 1650 1655 1660 1665 1670 1675 1680 1685 1690 1695 1700 1705 1710 1715 1720 1725 1730 1735 1740 1745 1750 1755 1760 1765 1770 1775 1780 1785 1790 1795 1800 1805 1810 1815 1820 1825 1830 1835 1840 1845 1850 1855 1860 1865 1870 1875 1880 1885 1890 1895 1900 1905 1910 1915 1920 1925 1930 1935 1940 1945 1950 1955 1960 1965 1970 1975 1980 1985 1990 1995 2000 2005 2010 2015 2020 2025 2030 2035 2040 2045 2050 2055 2060 2065 2070 2075 2080 2085 2090 2095 2100 2105 2110 2115 2120 2125 2130 2135 2140 2145 2150 2155 2160 2165 2170 2175 2180 2185 2190 2195 2200 2205 2210 2215 2220 2225 2230 2235 2240 2245 2250 2255 2260 2265 2270 2275 2280 2285 2290 2295 2300 2305 2310 2315 2320 2325 2330 2335 2340 2345 2350 2355 2360 2365 2370 2375 2380 2385 2390 2395 2400 2405 2410 2415 2420 2425 2430 2435 2440 2445 2450 2455 2460 2465 2470 2475 2480 2485 2490 2495 2500 2505 2510 2515 2520 2525 2530 2535 2540 2545 2550 2555 2560 2565 2570 2575 2580 2585 2590 2595 2600 2605 2610 2615 2620 2625 2630 2635 2640 2645 2650 2655 2660 2665 2670 2675 2680 2685 2690 2695 2700 2705 2710 2715 2720 2725 2730 2735 2740 2745 2750 2755 2760 2765 2770 2775 2780 2785 2790 2795 2800 2805 2810 2815 2820 2825 2830 2835 2840 2845 2850 2855 2860 2865 2870 2875 2880 2885 2890 2895 2900 2905 2910 2915 2920 2925 2930 2935 2940 2945 2950 2955 2960 2965 2970 2975 2980 2985 2990 2995 3000 3005 3010 3015 3020 3025 3030 3035 3040 3045 3050 3055 3060 3065 3070 3075 3080 3085 3090 3095 3100 3105 3110 3115 3120 3125 3130 3135 3140 3145 3150 3155 3160 3165 3170 3175 3180 3185 3190 3195 3200 3205 3210 3215 3220 3225 3230 3235 3240 3245 3250 3255 3260 3265 3270 3275 3280 3285 3290 3295 3300 3305 3310 3315 3320 3325 3330 3335 3340 3345 3350 3355 3360 3365 3370 3375 3380 3385 3390 3395 3400 3405 3410 3415 3420 3425 3430 3435 3440 3445 3450 3455 3460 3465 3470 3475 3480 3485 3490 3495 3500 3505 3510 3515 3520 3525 3530 3535 3540 3545 3550 3555 3560 3565 3570 3575 3580 3585 3590 3595 3600 3605 3610 3615 3620 3625 3630 3635 3640 3645 3650 3655 3660 3665 3670 3675 3680 3685 3690 3695 3700 3705 3710 3715 3720 3725 3730 3735 3740 3745 3750 3755 3760 3765 3770 3775 3780 3785 3790 3795 3800 3805 3810 3815 3820 3825 3830 3835 3840 3845 3850 3855 3860 3865 3870 3875 3880 3885 3890 3895 3900 3905 3910 3915 3920 3925 3930 3935 3940 3945 3950 3955 3960 3965 3970 3975 3980 3985 3990 3995 4000 4005 4010 4015 4020 4025 4030 4035 4040 4045 4050 4055 4060 4065 4070 4075 4080 4085 4090 4095 4100 4105 4110 4115 4120 4125 4130 4135 4140 4145 4150 4155 4160 4165 4170 4175 4180 4185 4190 4195 4200 4205 4210 4215 4220 4225 4230 4235 4240 4245 4250 4255 4260 4265 4270 4275 4280 4285 4290 4295 4300 4305 4310 4315 4320 4325 4330 4335 4340 4345 4350 4355 4360 4365 4370 4375 4380 4385 4390 4395 4400 4405 4410 4415 4420 4425 4430 4435 4440 4445 4450 4455 4460 4465 4470 4475 4480 4485 4490 4495 4500 4505 4510 4515 4520 4525 4530 4535 4540 4545 4550 4555 4560 4565 4570 4575 4580 4585 4590 4595 4600 4605 4610 4615 4620 4625 4630 4635 4640 4645 4650 4655 4660 4665 4670 4675 4680 4685 4690 4695 4700 4705 4710 4715 4720 4725 4730 4735 4740 4745 4750 4755 4760 4765 4770 4775 4780 4785 4790 4795 4800 4805 4810 4815 4820 4825 4830 4835 4840 4845 4850 4855 4860 4865 4870 4875 4880 4885 4890 4895 4900 4905 4910 4915 4920 4925 4930 4935 4940 4945 4950 4955 4960 4965 4970 4975 4980 4985 4990 4995 5000 5005 5010 5015 5020 5025 5030 5035 5040 5045 5050 5055 5060 5065 5070 5075 5080 5085 5090 5095 5100 5105 5110 5115 5120 5125 5130 5135 5140 5145 5150 5155 5160 5165 5170 5175 5180 5185 5190 5195 5200 5205 5210 5215 5220 5225 5230 5235 5240 5245 5250 5255 5260 5265 5270 5275 5280 5285 5290 5295 5300 5305 5310 5315 5320 5325 5330 5335 5340 5345 5350 5355 5360 5365 5370 5375 5380 5385 5390 5395 5400 5405 5410 5415 5420 5425 5430 5435 5440 5445 5450 5455 5460 5465 5470 5475 5480 5485 5490 5495 5500 5505 5510 5515 5520 5525 5530 5535 5540 5545 5550 5555 5560 5565 5570 5575 5580 5585 5590 5595 5600 5605 5610 5615 5620 5625 5630 5635 5640 5645 5650 5655 5660 5665 5670 5675 5680 5685 5690 5695 5700 5705 5710 5715 5720 5725 5730 5735 5740 5745 5750 5755 5760 5765 5770 5775 5780 5785 5790 5795 5800 5805 5810 5815 5820 5825 5830 5835 5840 5845 5850 5855 5860 5865 5870 5875 5880 5885 5890 5895 5900 5905 5910 5915 5920 5925 5930 5935 5940 5945 5950 5955 5960 5965 5970 5975 5980 5985 5990 5995 6000 6005 6010 6015 6020 6025 6030 6035 6040 6045 6050 6055 6060 6065 6070 6075 6080 6085 6090 6095 6100 6105 6110 6115 6120 6125 6130 6135 6140 6145 6150 6155 6160 6165 6170 6175 6180 6185 6190 6195 6200 6205 6210 6215 6220 6225 6230 6235 6240 6245 6250 6255 6260 6265 6270 6275 6280 6285 6290 6295 6300 6305 6310 6315 6320 6325 6330 6335 6340 6345 6350 6355 6360 6365 6370 6375 6380 6385 6390 6395 6400 6405 6410 6415 6420 6425 6430 6435 6440 6445 6450 6455 6460 6465 6470 6475 6480 6485 6490 6495 6500 6505 6510 6515 6520 6525 6530 6535 6540 6545 6550 6555 6560 6565 6570 6575 6580 6585 6590 6595 6600 6605 6610 6615 6620 6625 6630 6635 6640 6645 6650 6655 6660 6665 6670 6675 6680 6685 6690 6695 6700 6705 6710 6715 6720 6725 6730 6735 6740 6745 6750 6755 6760 6765 6770 6775 6780 6785 6790 6795 6800 6805 6810 6815 6820 6825 6830 6835 6840 6845 6850 6855 6860 6865 6870 6875 6880 6885 6890 6895 6900 6905 6910 6915 6920 6925 6930 6935 6940 6945 6950 6955 6960 6965 6970 6975 6980 6985 6990 6995 7000 7005 7010 7015 7020 7025 7030 7035 7040 7045 7050 7055 7060 7065 7070 7075 7080 7085 7090 7095 7100 7105 7110 7115 7120 7125 7130 7135 7140 7145 7150 7155 7160 7165 7170 7175 7180 7185 7190 7195 7200 7205 7210 7215 7220 7225 7230 7235 7240 7245 7250 7255 7260 7265 7270 7275 7280 7285 7290 7295 7300 7305 7310 7315 7320 7325 7330 7335 7340 7345 7350 7355 7360 7365 7370 7375 7380 7385 7390 7395 7400 7405 7410 7415 7420 7425 7430 7435 7440 7445 7450 7455 7460 7465 7470 7475 7480 7485 7490 7495 7500 7505 7510 7515 7520 7525 7530 7535 7540 7545 7550 7555 7560 7565 7570 7575 7580 7585 7590 7595 7600 7605 7610 7615 7620 7625 7630 7635 7640 7645 7650 7655 7660 7665 7670 7675 7680 7685 7690 7695 7700 7705 7710 7715 7720 7725 7730 7735 7740 7745 7750 7755 7760 7765 7770 7775 7780 7785 7790 7795 7800 7805 7810 7815 7820 7825 7830 7835 7840 7845 7850 7855 7860 7865 7870 7875 7880 7885 7890 7895 7900 7905 7910 7915 7920 7925 7930 7935 7940 7945 7950 7955 7960 7965 7970 7975 7980 7985 7990 7995 8000 8005 8010 8015 8020 8025 8030 8035 8040 8045 8050 8055 8060 8065 8070 8075 8080 8085 8090 8095 8100 8105 8110 8115 8120 8125 8130 8135 8140 8145 8150 8155 8160 8165 8170 8175 8180 8185 8190 8195 8200 8205 8210 8215 8220 8225 8230 8235 8240 8245 8250 8255 8260 8265 8270 8275 8280 8285 8290 8295 8300 8305 8310 8315 8320 8325 8330 8335 8340 8345 8350 8355 8360 8365 8370 8375 8380 8385 8390 8395 8400 8405 8410 8415 8420 8425 8430 8435 8440 8445 8450 8455 8460 8465 8470 8475 8480 8485 8490 8495 8500 8505 8510 8515 8520 8525 8530 8535 8540 8545 8550 8555 8560 8565 8570 8575 8580 8585 8590 8595 8600 8605 8610 8615 8620 8625 8630 8635 8640 8645 8650 8655 8660 8665 8670 8675 8680 8685 8690 8695 8700 8705 8710 8715 8720 8725 8730 8735 8740 8745 8750 8755 8760 8765 8770 8775 8780 8785 8790 8795 8800 8805 8810 8815 8820 8825 8830 8835 8840 8845 8850 8855 8860 8865 8870 8875 8880 8885 8890 8895 8900 8905 8910 8915 8920 8925 8930 8935 8940 8945 8950 8955 8960 8965 8970 8975 8980 8985 8990 8995 9000 9005 9010 9015 9020 9025 9030 9035 9040 9045 9050 9055 9060 9065 9070 9075 9080 9085 9090 9095 9100 9105 9110 9115 9120 9125 9130 9135 9140 9145 9150 9155 9160 9165 9170 9175 9180 9185 9190 9195 9200 9205 9210 9215 9220 9225 9230 9235 9240 9245 9250 9255 9260 9265 9270 9275 9280 9285 9290 9295 9300 9305 9310 9315 9320 9325 9330 9335 9340 9345 9350 9355 9360 9365 9370 9375 9380 9385 9390 9395 9400 9405 9410 9415 9420 9425 9430 9435 9440 9445 9450 9455 9460 9465 9470 9475 9480 9485 9490 9495 9500 9505 9510 9515 9520 9525 9530 9535 9540 9545 9550 9555 9560 9565 9570 9575 9580 9585 9590 9595 9600 9605 9610 9615 9620 9625 9630 9635 9640 9645 9650 9655 9660 9665 9670 9675 9680 9685 9690 9695 9700 9705 9710 9715 9720 9725 9730 9735 9740 9745 9750 9755 9760 9765 9770 9775 9780 9785 9790 9795 9800 9805 9810 9815 9820 9825 9830 9835 9840 9845 9850 9855 9860 9865 9870 9875 9880 9885 9890 9895 9900 9905 9910 9915 9920 9925 9930 9935 9940 9945 9950 9955 9960 9965 9970 9975 9980 9985 9990 9995 9999

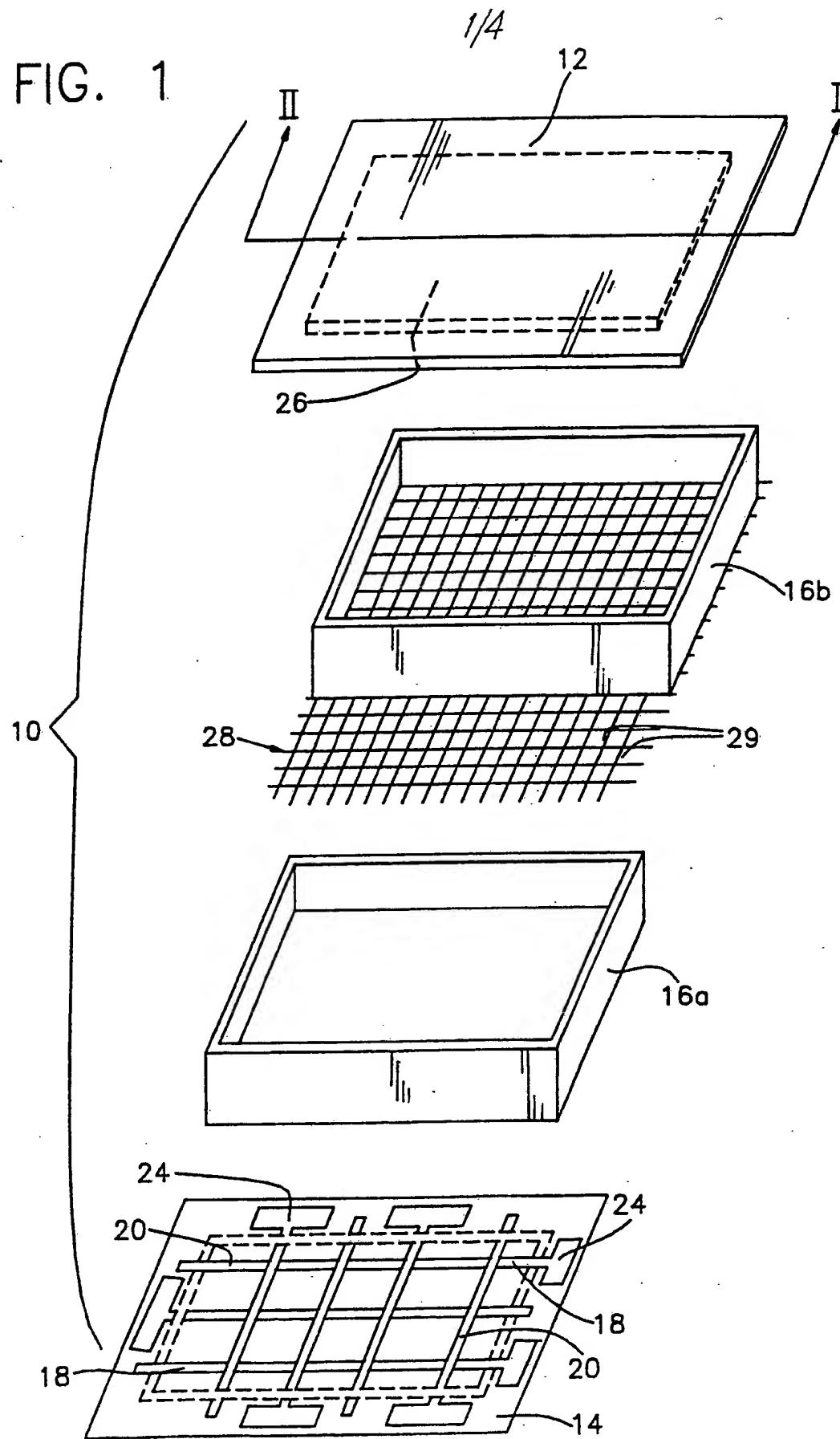
5        said control means approximate voltage levels of +200 v to said conventional anode, +140 v to said screen; 0 v to said additional anode, -10 v to said grid matrix and +1.5 to 3.0 v to said cathode matrix, then 100 v rms to said screen for 2 seconds, -300 v to said screen, then disconnecting said source of electrical potential from said conventional anode, said additional anode, said grid matrix, said cathode matrix and said screen, in that order.

10       58. The method of Claim 56, wherein said display operations include placing said display in a POWER-OFF-IMAGE-HOLD mode wherein a written said image is held on said display after the removal of power from said display, said POWER-OFF-IMAGE-HOLD mode being achieved by said source providing under the control of said control means approximate voltage levels of +200 v to said conventional anode, -300 v to said screen, +200 v to said additional anode, -10 v to said grid matrix and +1.5 to 3.0 v to said cathode matrix, then disconnecting said source of electrical potential from said conventional anode, said additional anode, said grid matrix, said cathode matrix and said screen, in that order.

15

20

FIG. 1



SUBSTITUTE SHEET

2/4

FIG. 2

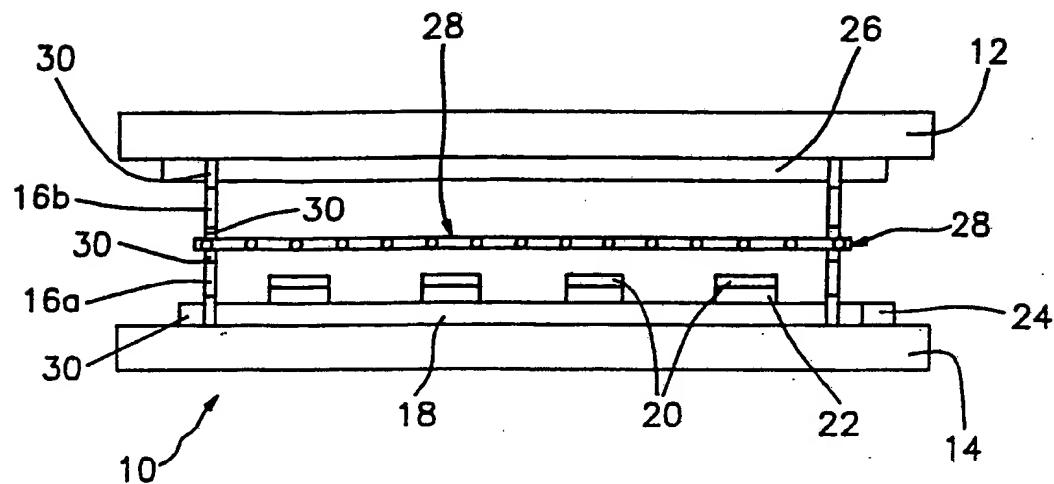


FIG. 4

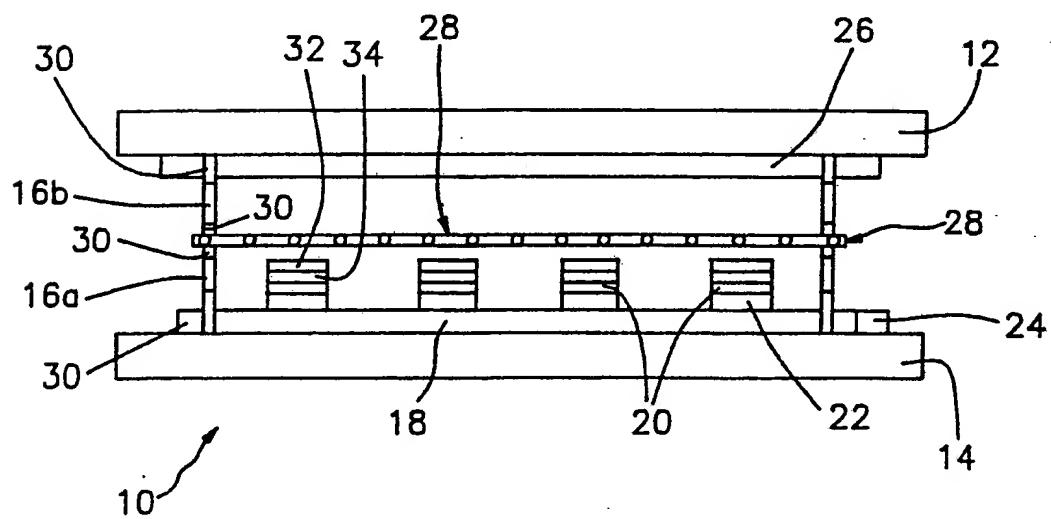
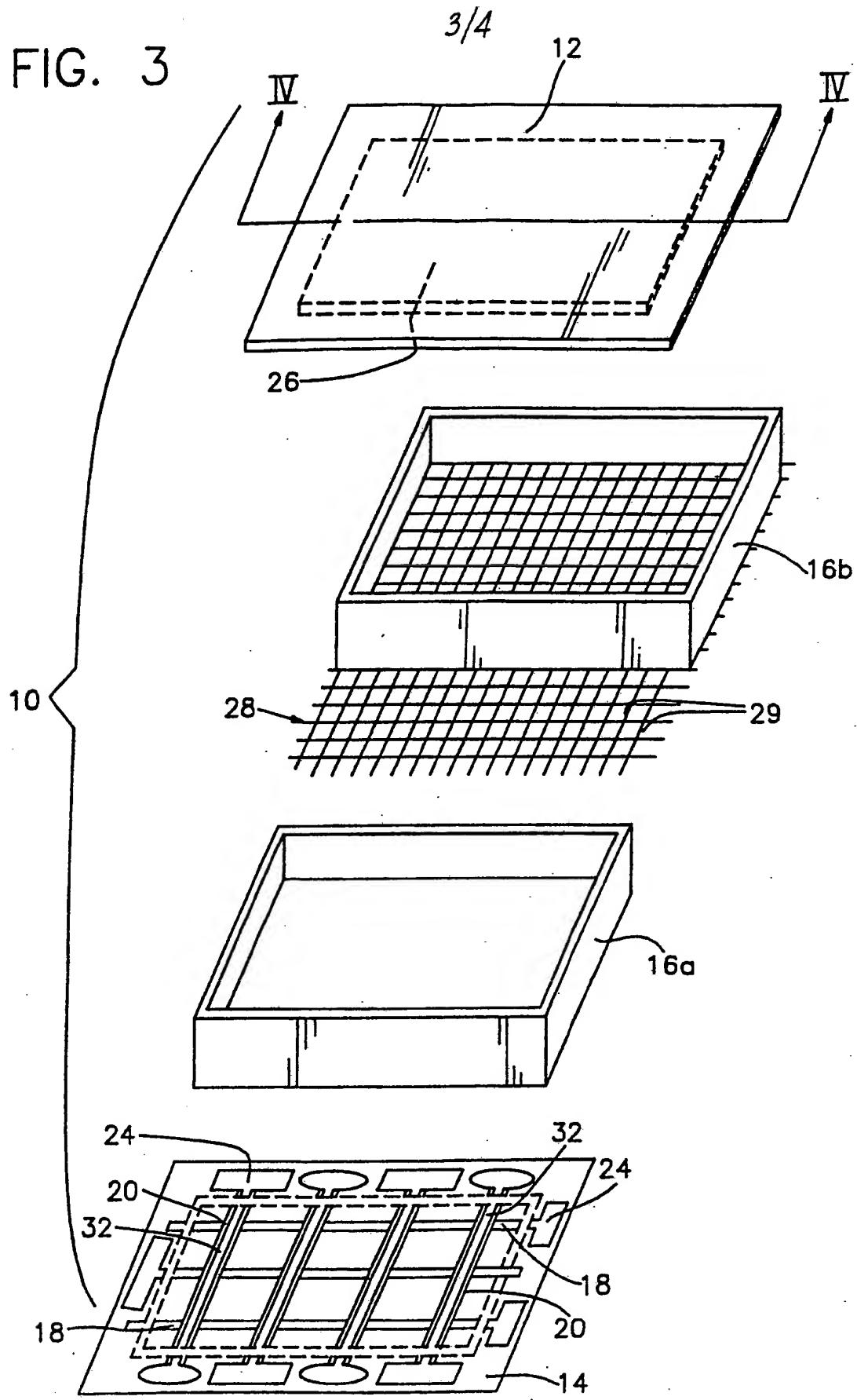


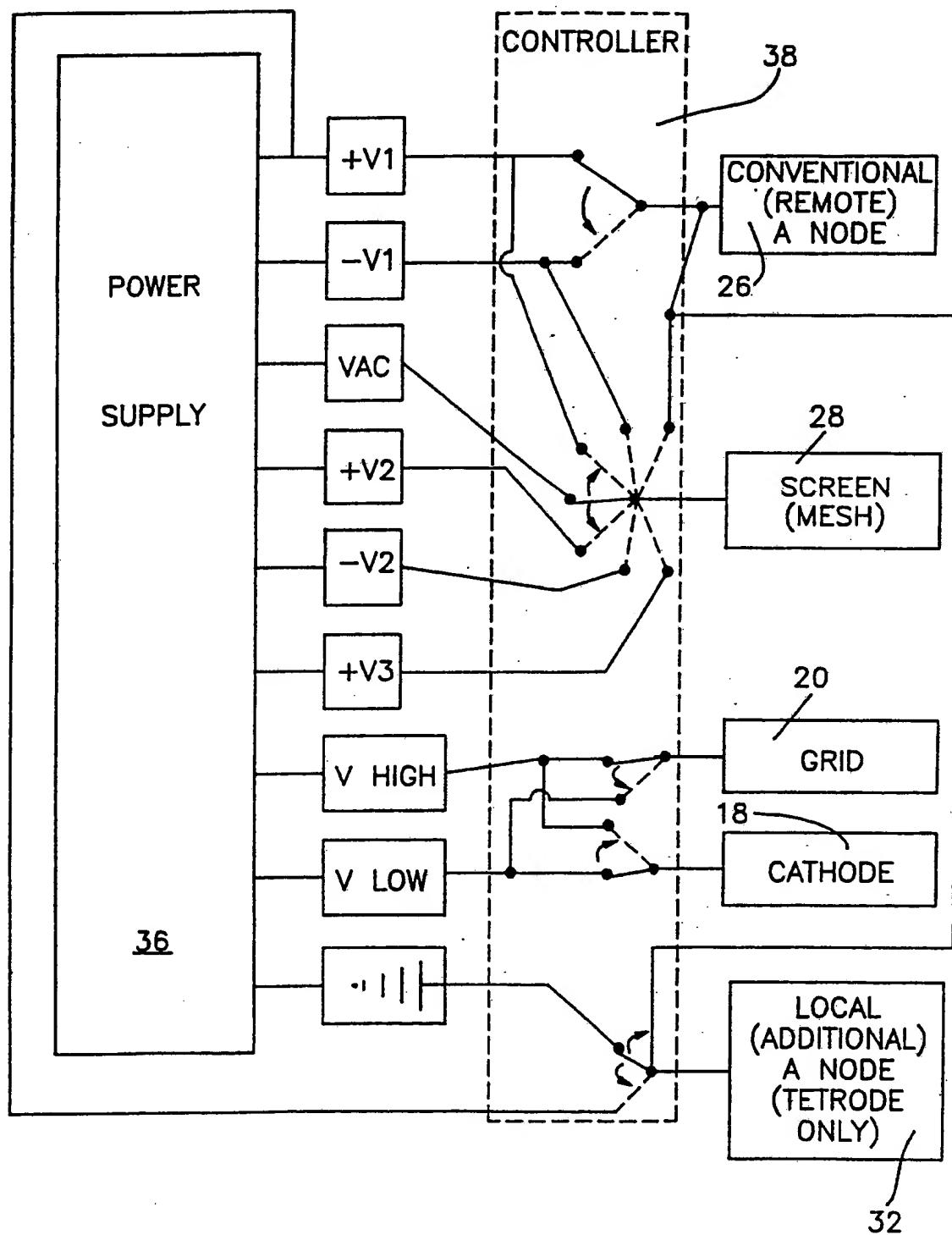
FIG. 3



## **SUBSTITUTE SHEET**

4/4

FIG. 5



# INTERNATIONAL SEARCH REPORT

International Application No. PCT/US91/06029

## I. CLASSIFICATION OF SUBJECT MATTER (if several classification symbols apply, indicate all) \*

According to International Patent Classification (IPC) or to both National Classification and IPC

IPC(5): G02B 26/00 // G09G 3/34

US CL : 359/296 // 340/787

## II. FIELDS SEARCHED

Minimum Documentation Searched ?

Classification System	Classification Symbols
U.S.	359/296; 340/787

Documentation Searched other than Minimum Documentation  
to the Extent that such Documents are Included in the Fields Searched \*

## III. DOCUMENTS CONSIDERED TO BE RELEVANT \*

Category *	Citation of Document, * with indication, where appropriate, of the relevant passages **	Relevant to Claim No. 13
A, P	US, A, 5,041,824 20 AUGUST 1991 Note column 3, lines 56-60, column 5, lines 15-21.	
A	US, A, 3,668,106 06 JUNE 1972	

\* Special categories of cited documents: \*

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier document but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"G" document member of the same patent family

## IV. CERTIFICATION

Date of the Actual Completion of the International Search

26 NOVEMBER 1991

International Searching Authority

ISA/US

Date of Mailing of this International Search Report

13 DEC 1991

Signature of Authorized Officer

EVELYN A. LESTER